Development of a Regional Coastal and Open Ocean Forecast System

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LONG-TERM GOALS

The long term goal is to construct, verify and demonstrate an efficient system for the realistic, accurate and efficient estimation of oceanic fields which can be deployed rapidly in any region of the world ocean: the coastal and shelf ocean, across the shelfbreak and the open ocean.

OBJECTIVES

The objectives of this research are: i) to continue the development of a relocatable, portable and efficient ocean prediction system for realtime forecasting and interdisciplinary research; ii) to demonstrate and validate HOPS in realtime exercises at sea and on land; iii) to implement regional forecast system methodologies; and, iv) to share software with the modeling and operational community.

APPROACH

The approach to software implementation within the Harvard Ocean Prediction System allows simple and flexible inter-module flow of information and the addition of models and procedures developed in-house or elsewhere. Standard data management procedures, data formats, generic data assimilation schemes amenable for use in diverse models are required. The approach to data assimilation emphasizes treatment of the data before assimilation via Structured Data Models (e.g. feature models and EOFs) which are used to represent synoptic structures. The approach to regional forecast system development involves: an Exploratory phase in which dominant scales, processes and interactions are identified; a Dynamical phase which establishes the circulation structures, the processes of synoptic evolution and events, and calibrates the regional system; and, a Predictive phase involving forecast experiments to verify the regional forecast system.

WORK COMPLETED

Completed software improvements to HOPS include: the inclusion of an external tide component (tidal mixing model); 2-way nesting with refined coasts and topography; control of an incorrect vertical component to the Shapiro filter; corrections to the boundary conditions and surface forcing. The portability of HOPS continues to improve through the feedback from external users. ESSE smoothing codes have been tested and analysis software added to HOPS.

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Real time operations:
1. MASSACHUSETTS BAY - HOPS was utilized during the LOOPS/AFMIS Massachusetts Bay Sea Trial '98. Over the period 17 August through 5 October, data was collected, processed and assimilated into ongoing numerical simulations of the Massachusetts Bay/Cape Cod Bay dynamical system. Nowcasts and forecasts were provided to the scientific community via a web page (http://www.deas.harvard.edu/~leslie) on a real-time basis. Sampling plans were adaptively modified based on dynamical error estimates (ESSE).

2. RAPID RESPONSE (RR98) - HOPS was utilized during Rapid Response 98 in the Gulf of Cadiz to provide continuing (February-March) operational forecasts and products (temperature profiles, currents, etc.) and in the adaptive sampling design (via ESSE) of AXBT flights. Initial tests of the assimilation of remotely sensed chlorophyll data (SeaWiFS) proved successful in a demonstration of concept of the potential use of bioluminescence data. Forecasts of tidal velocities were also produced.

RESULTS

As noted above, HOPS was utilized, demonstrated and validated for several regimes in real-time exercises during the previous year. These exercises, completed in collaboration with scientists from a number of institutions, indicate the flexibility and adaptability of HOPS, given the variety of regions and configurations. The Mass. Bay Sea Trial was a multi-scale, multi-disciplinary demonstration of concept of a multi-purpose generic system with adaptive sampling. The focus of the Sea Trial was on coupled physics-biology with an emphasis on phytoplankton and zooplankton patchiness.

HOPS interdisciplinary simulations during RR98 were largely successful. Evolution of the inflow and outflow through the Strait of Gibraltar was simulated in a realistic manner. It was found that chlorophyll-a data could be assimilated into HOPS and the evolution of the data field predicted.

HOPS is vertically integrated within the Harvard oceanography research group, facilitating interactions in fundamental and applied areas of research. HOPS is used for demonstration and validation of regional forecasting systems, fundamental research in ocean processes in the coastal and shelfbreak regions, a testbed for new data assimilation schemes and interdisciplinary work in biogeochemical modeling and simulations. The system has been distributed to several national and foreign research and operational sites. On-going training and collaborations using HOPS in various regions of the world ocean are presently being pursued.

IMPACT/APPLICATIONS

Ocean Prediction Systems (OPSs) for contemporary ocean science and marine technology consist generally of: i) a set of coupled interdisciplinary models; ii) an observational network with multiple platforms and sensors; and, iii) data assimilation schemes with measurement models and error models. The nowcasts, forecasts and data driven simulation products of OPSs have important applications for: i) the efficient conduct of real-time scientific research in the intermittent ocean; ii) marine resource exploration, exploitation and management; and, iii) naval and marine operations.

TRANSITIONS

Completed and continuing research transitions and collaborations are with: MIT Sea Grant; Southampton Oceanography Center; NRL Stennis; Naval Postgraduate School; SACLANT Undersea Research Centre; WHOI; SIO; Univ. of Colorado; JPL Pasadena; Old Dominion University; Institute of Marine Sciences, Turkey; U. Tokyo; CNR Ancona, Italy; Dartmouth College; University of Warwick, UK; Penn State Univ., Applied Research Lab.; and U. Mass. Dartmouth, Center for Marine Science and Technology.

RELATED PROJECTS

This project has relationships to the National Ocean Partnership Program in the development of the scientific and technical conceptual basis of a generally applicable Littoral Ocean Observing and Predictive System (LOOPS) with Johns Hopkins University (APL), MIT - AUV Lab., MIT - Sea Grant, MIT - Ocean Engineering, Naval Underwater Warfare Center, National Marine Fisheries Service, Raytheon, Tracor Applied Science, Univ. of California - Santa Barbara, Univ. of Massachusetts – Dartmouth; research towards the construction of an Advanced Fisheries Management and Information System (AFMIS) with U. Mass-Dartmouth (Prof. B. Rothschild), BIO-OPTICS research (Dr. Jeffrey Dusenberry), the Shelfbreak PRIMER and Harvard 6.1 research ("Dynamics of Oceanic Motions"), as well as external collaborations in conjunction with transitions.

PUBLICATIONS

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